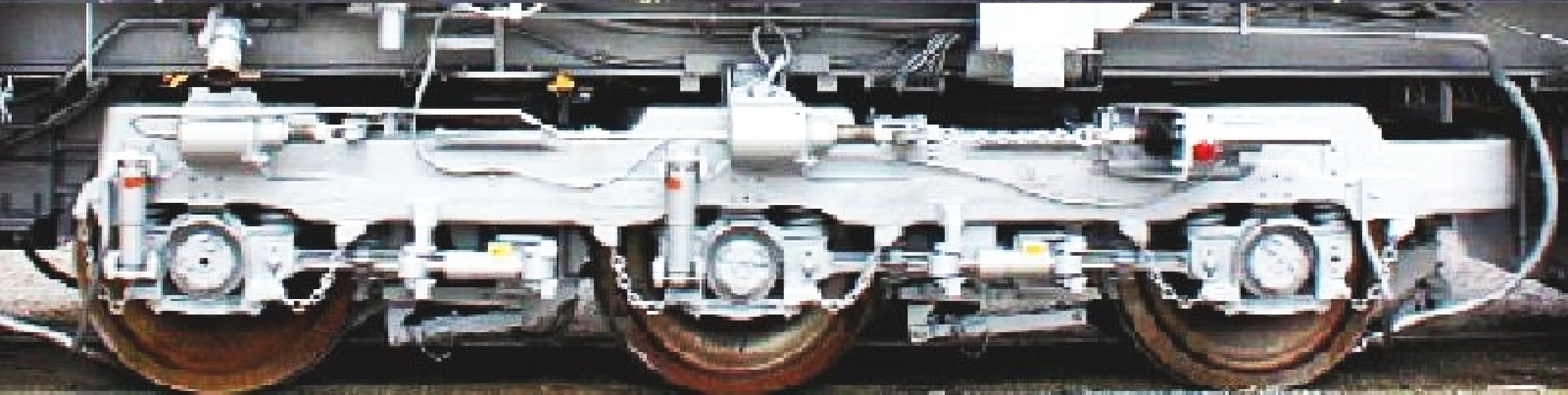
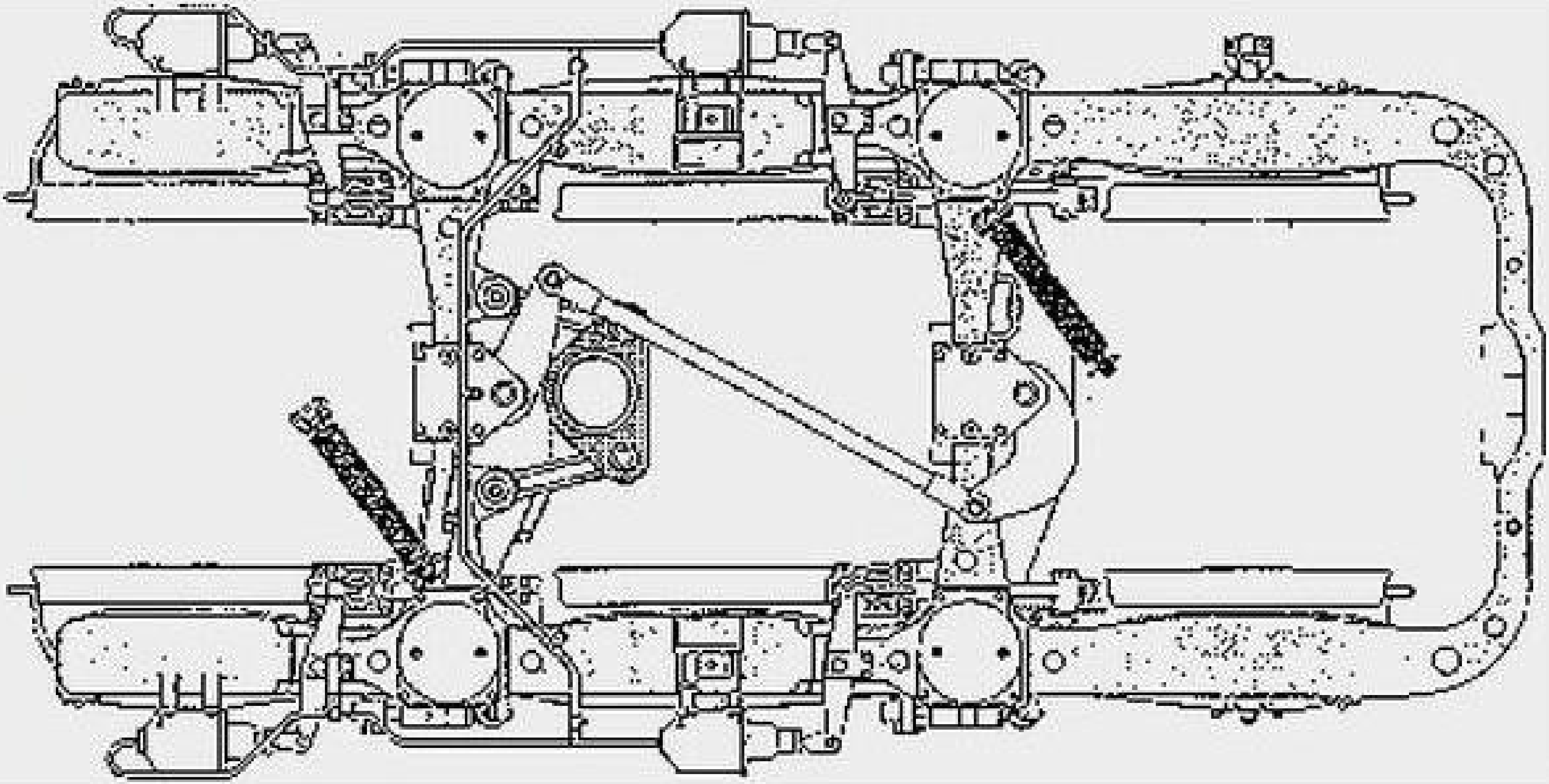


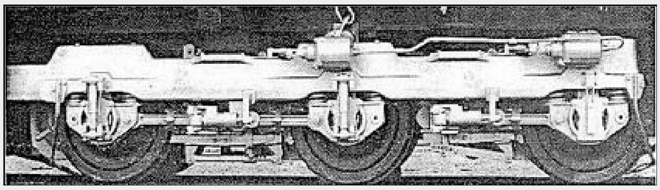




Articles

HTCR Radial Trucks

The trucks under the locomotive serve as much more than just a frame or guide for wheel sets and traction motors. Trucks provide stability to the locomotive in operation and have a direct effect on ride quality. A poorly designed truck may allow for an unstable locomotive, or may provide poor ride quality resulting in lower component longevity and tired, uncomfortable operating crews. But perhaps the most important factor affected by truck design is wheel/rail adhesion. With these concerns in mind, Electo-Motive has spent decades of time and millions of dollars in research and development of new trucks such as the patented HTC and most recently the patented HTCR radial truck.

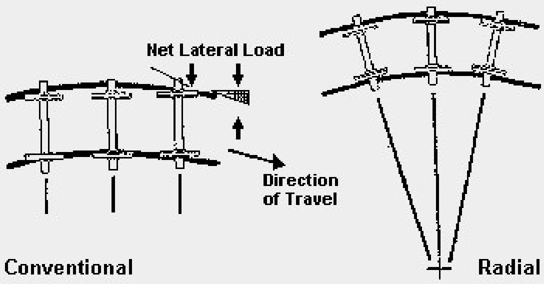


Truck Dynamics

When powering motors in a truck, the torque generated has a tendency to tip the truck with the leading end rising up, and the trailing end digging in much like a car does when pressing on the accelerator. This tipping of the truck will shift the axle loads putting more weight over the trailing axle, and less over the leading axle. Since adhesion is directly dependent upon the weight over the driver, the leading axle will tend to slip much more easily than the other axles. The more torque generated by the motors, the more the truck will tend to slip.

Years ago, EMD revealed its revolutionary HTC truck to the industry. This design, implementing new motor orientation, works to counteract the tipping motion caused by powering the motors. By centering the weight of the locomotive on a bolster and then distributing the weight toward the corners of the truck, the HTC allows for more usable tractive effort from a locomotive. When this design was envisioned, locomotive technologies had not yet been developed that would require all weather adhesion ratings in excess of 25-27 percent. Since the HTC is not as effective in minimizing weight shift at adhesion levels above 25-27 percent, developing a new design that would provide enhanced weight distribution under all conditions became the new focus of truck development at Electro-Motive.

The product of nearly ten years of development came in the first production HTCR radial trucks in early 1993. Not only did the new radial design conquer the challenge of more evenly distributed axle loads under high adhesion conditions, but it also provided a self-steering mechanism to improve the angle of attack in curves, reduce flange and rail wear, and improve ride quality.



Conventional "rigid" axle mounting produces greater lateral loading on the rails. Driving wheels may have a greater tendency to slip. Radial alignment in trucks allows for reduced flange wear and lower rolling resistance.

HTCR-II Trucks

In 1995, Electro-Motive released HTCR-II with the introduction of its SD80MAC and SD90MAC locomotives. This design included new features such as electric parking brake, 45 inch wheelsets, and split journal bearing adapters. HTCR-II also fits any 70 Series unit.

The HTCR-II truck distributes the weight of the locomotive toward the corners of the truck as did the HTC, however, the

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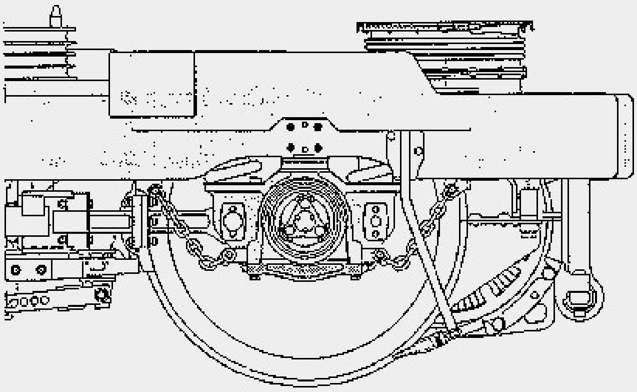
method is a bit different. Implementing a bolsterless design, HTCR-II rests weight toward its four corners using rubber compression springs (secondary springs). Reactions to weight shift by the HTC and HTCR-II are identical up to 25-27 percent adhesion. At this point, the center bearing/bolster interface of the HTC will begin to change. Since the radial truck has no bolster, low weight shift continues as it had up to this point and on into extremely high levels of adhesion.

To fully understand the main components of the new truck design, let's build the truck from the ground up. The following description will include those components associated with steering, motor mounting, weight distribution, and stability.

HTCR-II Trucks



The end axles are "free floating"; they do not anchor directly to the truck frame. On rigid trucks, the forward or reverse motion of the wheel was transferred into the truck frame through pedestal liners. With the radial truck, though, a journal adapter is mounted over the journal bearing at either end of the axle. Directly connected to the adapter is half of an axle traction rod. The axle traction rod serves as both a steering mechanism and a means of transferring axle tractive energy into the truck frame, as will be seen later. The adapter also allows for two primary coil springs to rest on it, mounting for a rubber lateral deflection pad, and a vertical shock absorber. Two chains connect from the top half of the adapter to the truck frame. These retain the coil springs in the truck when removing a motor since motor removal only requires that the journal adapter cap be removed.

The coil springs insert into the truck's spring pockets. These springs are solitary springs (there are no "inner" sets that fit within the diameter of the outer). The rubber lateral deflection pad mates with a nylon wear plate which is mounted inside the spring pocket to serve as lateral stops for axle movement within the truck frame.

The center mounted traction motor is allowed 0.62 inches of lateral freedom, but is not provided any pivoting action as the end axles are. This design provides radial alignment of each driving axle (wheelset) to the rail in a curve for maximum contact between the wheel treads and the top of the rail, with a minimal amount of lateral force between the wheel flanges and the sides of the rails.

Steering Beam and Axle Traction Rod

The previous discussion mentioned half of an axle traction rod. This discussion talks of the other half of this component and another dual purpose element called a steering beam.

The axle traction rod transfers axle motion to the truck frame through the steering beam. In addition to transferring traction movement, the axle traction rods and steering beam make up part of the "steering system" within the truck. As an end axle pivots, its traction rod will move longitudinally with respect to this pivoting. Because the axle traction rod connects to the steering beam, it too will pivot. The pivoting action moves the inter-axle steering link. This steering linkage runs diagonally across the truck and mates with an identical steering beam assembly for the other end axle. Because of this link, the pivot of one end axle will cause the opposite pivoting rotation for the opposing axle which is ideal for steering through curves.

The steering beam has rubber stops mounted to it which mate with corresponding parts on the truck frame. These stops limit end axle rotation. The actual movement of the end axle in steering is limited to about one-half inch total. While this motion seems insignificant (and is difficult to detect with the naked eye), it results in a steering capability of about 8 degrees curvature. This makes a great difference for higher adhesion, reduced flange wear, and better ride.

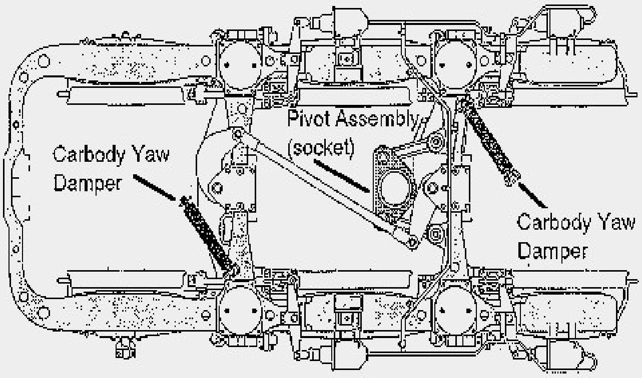
Lastly, the steering beam connects with a yaw damper at either side. The other end of the yaw damper links to the truck frame. At higher track speeds, the end axles have a tendency to pivot back and forth continually even on straight track. This motion is called yaw. The yaw dampers are shock absorbers that lessen pivoting oscillations.

The other purpose of the axle traction rods and steering beams is to transfer motive forces into the truck frame. Both the top and bottom of the post in the center of the steering beam connect with a plate mounted on the truck frame. The plate transfers motive force as well as provides a pivot point for the steering beam. The traction motor's anti-rotational stop is called the nose link. This takes the place of the traditional nose or spring pack that has been used on HTC rigid trucks. The motor connects to the nose link with two Huck Bolts. To remove the motor, these bolts must be destroyed.

Underframe to Truck Frame Components

The previous text describes how tractive effort is transmitted from the axles to the truck frame, but this energy needs to be transferred to the locomotive's underframe whereupon it becomes drawbar pull. This is accomplished by using a pivot (center) pin and pivot assembly (socket) along with two carbody traction rods. Carbody traction rods are similar to the axle traction rods discussed previously, but these are one solid piece. These rods connect with a pivot assembly or socket into which the pivot pin fits. The pivot pin is welded to the locomotive's underframe.

The pivot pin does not bear the locomotive's weight. Its main purpose is to transfer motive forces. The secondary (rubber compression) springs bear the locomotive's weight. These are mounted toward the four corners of the truck frame. It is perfectly normal to see these rubber pads distort when the locomotive is sitting on a curve. The truck's stop limits mate with similar components which are welded to the locomotive's underframe. These components show slight "gouge" marks as a sign of normal wear. Last, additional yaw dampers are mounted between the truck frame and the locomotive's underframe. These are installed for damping mechanical oscillations of the truck frame which occur normally. A yaw damper mounts diagonally at either end of the truck frame as shown below.



Top view of HTCR.

In 1987, EMD fitted a test HTCR truck onto the cabs end of SD60 demonstrator EMD3, then tested it at TTC Pueblo & on ATSF's Raton Pass.
In 1990, EMD3s rear HTC truck was replaced with another HTCR truck, then further testing commenced at TTC Pueblo & on UP's Reno branch.
EMD3's test trucks were 13'5" wheelbase solidcast HTCRs, 2" shorter & 6000lbs heavier than the production 13'7" wheelbase hollow HTCRs.
The design was lengthened for larger more powerful traction motors, that were required for the planned SD70|SD75|SD80|SD90 locomotives.
In 1991, testing completed & EMD3 joined the BN Oakway fleet. In 2001, EMD3's shorter HTCR trucks were replaced with production HTCRs.